

dark orange-red spots, set wide apart from each other. Head rather produced and rounded, also spotted with red. Mouth circular, small, situated in front, without veil or tentacles. Branchial plumes 15 or 16, situated on the posterior third of the back, round a large disk, in the centre of which is the vent. Plumes long, downy, closely set, pure white, with a longitudinal bright-red streak on the back of each; slightly contractile, but they do not retract into a cavity; when extended, they resemble a small tuft of marabout feathers. Genital orifice in a nipple-like process situated between the anterior and middle third of body.

Foot long and broad, terminating posteriorly in a lancet-shaped point, about $\frac{1}{4}$ inch from the body; white, with a delicate light orange-red line on the edge; this line is carried partially on each side of the head. Tentacles 2, dorsal, short, conical, pointed; upper half indistinctly laminated; of a light orange-red colour at tip; base colourless, transparent.

Found on rocks and sea-weed, near 'Sober Island.'

This elegant creature does not resemble any of the described species.

I have ventured to make a distinct genus of this animal, and dedicate it to Sir Walter Trevelyan, to whom I am so much indebted for the liberal aid he has given me in my researches into the natural history of Ceylon.

The form of the body is not unlike that of the genus *Ancula*. Its nearest approach in other particulars is to *Polycera*.

They are short-lived in a vivarium. Ova yellow, deposited in bead-like coils. They generally deposit the coils on twigs of sea-weed. Sometimes this animal resembles a miniature fantail pigeon, particularly when perched on sea-weed, with the small marabout plumes elongated.

XXIII.—*Note on the Red Colouring Matter of the Sea round the Shores of the Island of Bombay.* By H. J. CARTER, Esq., H.C.S. Bombay*.

FROM "the plagues of Egypt" down to the present day, the blood-red colour which occasionally makes its appearance in fresh and salt water has been an object of wonder. Numbers of instances of it are recorded by navigators of all ages, as may be seen by reference to M. C. Dareste's excellent 'Mémoire' on the

* Communicated by the author; having been read at the Bombay Branch of the Royal Asiatic Society, January 14, 1858.

subject*. Besides red, spots of white, yellow, green, and brown water have been seen in different parts of the globe; but those of red and white are most common in the Arabian and Red Seas, and of these two the red will chiefly occupy us here. They are of transitory duration, and, so far as the red colour is concerned, receive explanation from what occurs at our own doors, viz. in the sea-water pools left by the reflux of the tide on the shores of the Island of Bombay. A person casually looking at one of these pools, would say that a quantity of vermilion or minium had been thrown into it; but, on examining the water under a microscope, the colour is seen to be owing to the presence of red animalcules, whose name is *Peridinium*. These are not all red, however, for there are many green ones among them; and the latter are further observed to be but a transitional state of the former. This, then, is the cause of the red colour, and its sudden appearance and disappearance may be explained as follows:—

During the first or active part of the *Peridinium's* life, its green colour, which depends upon the presence of a substance closely allied to, if not identical with, the chlorophyll of plants, is, with the other internal contents, translucent, and therefore reflects little or no light; but gradually, as the time approaches for its transition to another state, called the motionless, fixed, or Proto-coccus-form, a number of semi-translucent, refractive oil-globules are secreted in its interior, directly or by transition from starch, the green colour disappears, a bright red takes its place; this mixes with the oil, and thus the little animalcule finally becomes visible to the naked eye, and the whole of that portion of the sea charged with them, of course, acquires a deep vermilion colour. This colour, however, only lasts for a few days, for they soon assemble together, become individually capsuled, like *Euglena viridis*, and in this state float on the surface or sink to the bottom in the motionless, Protococcus-form mentioned. Here duplicative subdivision takes place in several of the capsules, producing two or four new ones from the old *Peridinium*, each of which, on their liberation, may again become capsuled and undergo a further division, and so on, probably, until their formative force is expended, and they thus pass into dissolution;—or a litter of diplo-ciliated monads may be developed in a distinct cell in their interior, which may be the product of a true act of generation, or the final formative effort of the protoplasm,—a point to which I have already called attention in many of the Algæ and Infusoria; while the remainder of the red oil and internal contents which are not required for the nourishment of the monads become liberated with the latter on the bursting of the capsule, and thus dispersed in the water. A further con-

* Ann. des Sc. nat. 4 sér. Zool. t. iii. p. 179.

sequence of the fission is the constant shedding of their capsules, which are always present with them in great numbers, and so brittle that pressure of the thinnest piece of glass bursts them, and again sets free the *Peridinium* when they contain one: iodine in dilute sulphuric acid gives them a deep violet colour, and the red matter of the *Peridinium* is also frequently rendered deep blue by the same solution.

Thus we see that the red colour is produced by the formation of oil reddened at the expense of the green chlorophyll. The same process takes place in the little *Protococcus* which I have heretofore shown to impart the red colour to the salt in the salt-pans of Bombay; and, again, in a freshwater animalcule closely allied to *Peridinium*, viz. *Euglena viridis* (probably Ehrenberg's *E. sanguinea* is but a reddened state of the latter); while a more familiar illustration than any is presented to us by the red colour which the leaves of some trees assume towards death, viz. the passing of the green chlorophyll and oil into a yellow, brown, and then red waxy substance; from whence we may also infer, that like changes in the *Peridinium* give rise to the prevalence of one or other of these tints in the coloration of the sea.

The species of *Peridinium* now more particularly under our consideration I described several years since in its fixed form (as it was submitted to me) undergoing fission*; but never having met with it again in its active state until the 26th Nov. last, my attention was not again drawn to the subject, nor did I until then know what the animalcule really was. I shall call it animalcule, though, like *Euglena* and all this class, it really belongs much more to the vegetable than the animal kingdom; and, believing the species to have been hitherto unrecognized, its description, under the designation of *sanguineum*, may stand as follows:—

Peridinium sanguineum, nov. sp.

Subcircular when green, becoming larger and paraboloidal or kite-shaped when red. Compressed, sulcated on one side; surrounded transversely by a deep groove, the anterior lip of which is minutely ciliated. Furnished with a long, large cilium, having a suctorial extremity, which extends backward from the groove on the sulcated side. Body lined with granular protoplasm and chlorophyll, in which is a hyaline vesicle with a red eye-spot and a nucleus as in *Euglena*. Chlorophyll becoming of a golden yellow, then brownish, and lastly vermilion- or minium-red, as the animalcule passes into the *Protococcus*-state. Progression waddling, the small end forwards,

* Dr. Buist, "On Discolorations of the Sea," &c., Proceedings of the Bombay Geographical Society, 1855, p. 109.

and the large cilium floating behind. Capsule slightly tabulated over the anterior or conical half, smooth over the posterior or round half, which also bears a short sheath in its groove for the long cilium. Length 5 to 8-5600ths of an inch.

Found in salt-water pools, and in the sea on the shores of the island of Bombay.

What, then, accounts for the red colour of the sea and salt in the salt-pans at Bombay may account for the red colour in the sea-water of other parts, although the animalcules may not be the same,—viz. the formation of red oil in their interior. It is interesting, however, to find Darwin's description of the animalcule which he found to colour the sea red, a degree south of Valparaiso*, accord exactly with that of *Peridinium*, as may be seen by comparing our descriptions; while it is not less so to find Salt† stating that the animalcules which produced the red colour in the Red Sea (15° N.) during the day, became luminous and threw out sparks by agitation after dark; because most of Ehrenberg's marine *Peridinae* are phosphorescent. In further confirmation of which, Olafsen and Povelsen's statement may be adduced respecting the red colour of the sea on the shores of Iceland, viz. that in 1649, in several gulfs, "the night before, the sea appeared all on fire, and the day following as red as blood." But it is not necessary for me to cite here all the observations in M. Dareste's 'Mémoire' in favour of the red colour of the sea being in many instances owing to the presence of *Peridinae*, or the white colour to the same animalcules; suffice it to state that there are many.

With the explanation of the red colour, then, we have that of the white, which is only seen at night, and appears to be produced by phosphorescence generated in the midst of the oil-globules, becoming less and less powerful probably as the *Peridinium* becomes redder and more nearly approaches to the fixed or Protococcus-form. I do not of course allude here to the colour of what is termed 'whale-water,' or to the accumulation of any molluscous animals that can be seen with the naked eye, but exclusively to the colour of water produced by animalcules, which also must again be distinguished from those that are feeding on them, for where the former abound the latter are also sure to be present. Here I have to express my regret that I allowed the red water under consideration to pass away before I thought of ascertaining if the *Peridinium* which coloured it was also phosphorescent.

Again, the yellow colour may be produced by the chlorophyll

* Journal on board H.M.S. 'Beagle,' p. 17.

† Voyage to Abyssinia, p. 195.

passing into a golden tint, when the oily appearance, so often noticed on the surface of the sea, might be produced; so also the green colour may precede the change into brown and red, as stated in parts of the 'Mémoire' under reference, extracted from Parry and Scoresby's journals. Scoresby, too, notices that the animalcule was "paraboloidal," and he gives measurements equally small with those of a *Peridinium*.

On the brown colour a word also is necessary. This, which probably depends on the presence of a *Peridinium* in the sea, certainly does so on land, for I have had ocular demonstration of it in a freshwater tank at Bombay, where, in the beginning of February 1857, it not only turned the water quite brown, but imparted a smell and insipid taste to it, which almost rendered it undrinkable. Professor Allman has described the same phenomenon from equal evidence, in the ponds of the Phoenix Park, Dublin*; but the figure he gives of that *Peridinium*, though very like, is not the same as that of the species of Bombay.

Nor should I omit to notice here the æruginous green colour which frequently occurs in our tanks, from the presence chiefly of a little Alga called *Flos-aquæ*, with which the acicular, fusiform *Aphanizomenon Flos-aquæ* (Linn.) and curled-up, bead-like *Monormia intricata* (Berk.) are plentifully mingled. This occurs so generally and so abundantly, as frequently to render the water not only undrinkable, but to produce an intolerable stench by its putrefaction—facts which we cannot help associating with the blood-red water of Egypt; and when we add to this the following passage from an eye-witness of a similar occurrence at Porebunder, on the coast of Khattywar, where red water is extremely common, viz. "the colour of the sea-water on Saturday evening last, the 27th October, 1849, was changed from its usual tint to a deep red, emitting a most foul smell; the fish speedily were all destroyed, and were washed upon the beach in large quantities, &c.†"—we cannot help ascribing this, independently of the conjecture of the narrator that it might be owing to "some submarine eruption of mud, &c.," to the process of oleaginous development and change of colour above mentioned in some animalcule, most probably a *Peridinium*, and of realizing, at the same time, the (to me) previously incomprehensible Mosaic account of the plague of Egypt given in the following verses:—

....."and all the waters that were in the river were turned to blood."

"And the fish that was in the river died; and the river stank, and the Egyptians could not drink of the water of the river; and there was blood throughout all the land of Egypt."—*Exodus*, vii. 20, 21.

* Trans. Microscop. Soc. Lond. vol. iii. 1855.

† Proceedings Bombay Geograph. Soc. *loc. cit.*